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LIFE-HISTORIES OF SYRPHIDAE V.

C. L. METCALF.

***Syrphus xanthostoma* Williston. The Pemphagus-Gall Syrphus-Fly.**

(Plate IV, Figs. 81 to 89).

Larva.

Length about 10 mm. (8 to 11.5), width 3.75 to 4 mm., height 2.5 to 3 mm. Fat, thick, grub-like, sluggish larvæ, elongate oviform in outline, strongly arched dorsally (Fig. 82). Wrinkles prominent, produced laterally into an irregular, dorso-lateral carina; the ventral folds of the body in the principal segments serve as very imperfect prolegs. General color very pale, pinkish-yellow. Heart line not conspicuous. Skin bare, the segmental bristles short and light in color, very inconspicuous.

The jaws of the mouth-parts are unusually short, their width at base equal to their length, the lower jaw the heavier. Mouth-hooklets apparently three pairs: two near the jaws of which the ventral pair is the heavier, the third pair lateral in position, heaviest of all. There are a number of sensory papillæ around the mouth-parts and antennæ. The antennæ are small, situated close together above the jaws, of the usual form (see Fig. 81).

The prothoracic spiracles are slightly elevated, blunt, short, horn-shaped as seen from the side (Fig. 81, g), the semi-circular slit apparently guarded by six, blunt teeth, one of the median ones emarginate or imperfectly divided (Fig. 83). The posterior

respiratory appendage (Figs. 84, 85) is a fourth longer than broad, testaceous brown, ringed about mid-length, thence slightly constricted. The spiracles (*a*) moderately long, somewhat elevated above the surface; the inter-spiracular spines (*b*) short, blunt, spur-like, rather prominent. Dorsal spiracular spine (*c*) short, compressed; its breadth about equal to diameter of the approximate circular plate (*d*).

These larvæ were found, full-grown, at Cedar Point, July 7, 1911. The larval stage continued indoors to July 11 and 12.

They were collected on the Poplar or American Aspen (*Populus tremuloides* Mx.) in the well-known, characteristic galls on the ends of the twigs, made by the aphid, *Pemphagus vagabundus* Walsh.

These galls are large, commonly two inches in diameter, very irregular in shape, the outer surface thrown into numerous deep convolutions. Their structure is such that they enclose a number of small, partially separated chambers, the thick walls of which are lined by the aphids.

There are usually several openings to the many-chambered gall, but it is pretty certain that the larvæ do not ordinarily migrate from gall to gall; although there is a bare possibility that they might do so if the food supply in any one ran out. They are negatively heliotropic, seeking out protected dark corners when kept in confinement. They feed on the body contents of the aphids; hence there is commonly an abundance of food at hand and, as the volume of the chambers in the gall is small, there is no occasion, and little opportunity, for active movements. In correlation with this we find the larvæ very sluggish, lying quietly for hours or even days, even though unfed. Since migration from one of these galls to another would commonly involve traveling for several feet, it seems to me very likely that the larva or larvæ are dependent on the aphids within the single gall in which they begin their larval existence. They are very well protected within the poplar galls and I found no parasites affecting them. It would seem that they are paying for their well-fed, well-protected, sedentary life in sluggishness, and are possibly on the road to degeneration.

Pupa.

Dimensions, average of 5: Length 7.2 mm., height 3.5 mm., width 3.8 mm. These puparia (Figs. 86, 87) are exceptionally inflated dorsally, the ratio of height to length being greater than in any of the other species I have examined. It is characteristic of them also that the posterior inflation is equal to, or greater than, that anteriorly; in outline, as seen from the side, the dorsal half of the puparium makes an almost perfect semi-circle. The ventral line is sinuate. The respiratory appendage (*a*) projects from

the lower posterior part. From above, the outline is sub-ovoid, broadest in front of the middle, thence narrowing gradually to the posterior third; whence the puparium is strongly and unevenly compressed to the tip of the respiratory appendage.

Color at first grayish brown, sometimes marked with oblique patches of black; posterior breathing appendage darker. As the pupa approaches metamorphosis the anterior end darkens to deep reddish-brown in the region of the eyes; while on the posterior half, the three principal, yellow abdominal bands of the adult become visible through the transparent wall.

The segmental spines remain, as in the larva, very inconspicuous. The posterior breathing appendage also retains its characteristics.

Of three specimens taken on July 7, one pupated July 11, the other two the following day. The former emerged as adult July 18, the latter two July 20. Hence the duration in the pupal stage was 7 to 8 days. I did not determine the place of pupation and so cannot say whether, in the field, this stage is passed within the galls or not. Examination of a number of the galls later in the summer failed to reveal any puparia.

Adult.

Male: "Length, 11 to 12 mm. Face and cheeks wholly yellow, antennæ reddish yellow, the third joint somewhat brownish above, but little longer than wide, the arista black. Frontal triangle with a small black spot in the middle, gray pollinose along the eyes, black pilose in the middle. Dorsum of thorax shining metallic green, with light colored pile; lateral margins distinctly yellowish pollinose. Scutellum wholly yellow. Abdomen black, the anterior half of the black bands sub-opaque, the three principal bands very broad, attaining the lateral margins in nearly their full width; first band interrupted, the spots narrowly separated, with their inner ends rounded; second and third bands with a narrow but deep emargination in the middle behind; fifth and sixth segments with a yellow hind margin. The black forms narrower bands than the yellow, and does not quite reach the margin. Legs yellow, the tip of hind tibiæ and their tarsi brownish. Wings hyaline, the stigma yellowish.

Female: "Front metallic green, yellow below, on the lower half with yellowish pollen. Yellow spots of the second abdominal segment larger, more nearly square, and only narrowly separated." —Williston, Synop. N. A. *Syrphidae*, p. 86.

***Eristalis aeneas* Scopoli.**

(Plate V, Figs. 131 to 141 and 145 to 148; and Plate IV, Figs. 149, 150.)

Egg.

The egg of *Eristalis aeneas* was not found but that of its near relative *E. tenax* was studied and is figured in Plate V, Fig. 142.

These eggs are much larger than those of most of the aphidiphagous species studied, but are equaled in size by the egg of *Didea fasciata*. Length 1.6 mm., diameter 0.4 mm., elongate ovoid, slightly bent, rounded at the ends, the anti-micropylar end the larger. The shell shows the usual sculpturing but the radiating arms between the main bodies are much less conspicuous or at times apparently wanting (Fig. 143). There are about 65 bodies the length of the egg, about 100 around it at the middle. Each body is about two or three times as long as broad, with 9-13 short arms radiating from it. The bodies are well separated from each other. The color is the usual chalk-white.

A female of *E. tenax* was taken at the city sewage disposal plant while ovipositing over filth, September 23. Within an hour and a half after being taken she had deposited about 100 eggs. Part of these were deposited in more or less scattered positions; the great majority, however, in one or two masses, in which they were ranked on end, their sides closely apposed. They were floated over a vial of water, and within 24 hours a considerable number of them had hatched and were to be seen crawling on the vial or wriggling in the water.

Larva.

The young larva of *E. tenax* (Fig. 144) is scarcely longer than the egg except for the projection of the posterior respiratory appendage. Including this structure the length, 2 or 3 hours after hatching, was 2.5 to 3 mm. The larvæ are sub-cylindrical but attenuated at the posterior end to the breathing tube (Fig. 144, *d*). They frequently show a prominent hump dorsally in the posterior third of the body. Antennæ (*a*), prolegs (*b*), tracheal trunks (*c*), and other larval structures are present but these are described below for the larva of *E. aeneas*.

The mature larva of *Eristalis aeneas* (Fig. 131) resembles in a general way the well-known rat-tailed larva of *E. tenax*, but is considerably smaller.

The body is soft, slug-like, elongate-oval or sub-cylindrical in shape, about 13 to 15 mm. long by 3 to 4 mm. broad and 2 to 3 mm. high; these dimensions varying with the different positions assumed by the motile larva. The anterior end is commonly

retracted so as to be roughly truncate. At the posterior end the last segment tapers rather abruptly to the posterior respiratory appendage. This appendage (Fig. 131, *d*) is tube-like and very long. Its diameter near the body is usually about 0.5 mm. while at the end it is less than one-half this width. Its length varies extensively; it is seldom retracted to less than 5 mm. and may be elongated in exceptional instances to 100 mm. or nearly four inches. A more usual elongation is about 15 to 30 mm. The color of the larva is a dirty gray or brown.

The body-wall is soft, flexible, more or less greasy or slimy to the touch, and translucent. The integument has a number of transverse folds which terminate laterally in a moderately distinct lateral carina running the full length. These folds fall into a number of groups, between which the integument is smooth, each group consisting of about five transverse elevations or wrinkles. Near the middle of these groups of folds one can detect double, flexible hairs (Fig. 136, *a*), about twelve in number situated in a transverse row. The lateral margins of the body also are constricted between these groups of folds.

For these reasons I am convinced that these divisions of the body represent somites or body-segments. I suspect that the bifid, flexible hairs are homologous with the single, usually rigid, segmental hairs of the aphidiphagous forms which are similarly located with reference to segments. Determined in this way the body shows seven similar and perfect segments when in a retracted position. To these may apparently be added two posterior ones which bear the long respiratory tube and on which the anus opens ventrally. Immediately in front of these seven similar segments open the anterior respiratory cornua of the larva, which would represent a tenth segment. The remaining ones in front are indefinite, retractile, and bear the antennæ, a mouth-hood, and, within the buccal cavity, certain chitinized mouth-parts. If, as in the case of the aphidiphagous species, we consider the anterior larval spiracles as representing the prothoracic segment and allow, as in that case, two segments for the head, then this segment becomes No. 3, the last one of the seven would be No. 10, and the ones bearing the anus and respiratory appendage would make twelve in all.

The mouth-parts of the larva are located internal to a hood-like, striated, chitinous termination of the oesophageal framework. (Figs. 138, *b*; 139). They are peculiar structures which I have been unable to homologize with the parts in the aphidiphagous larvæ, but which seem to me to represent these structures in a degenerate condition. They are represented in Plate ———, Figs. 139, 140, 141, perhaps better than they can be described. Of the parts there figured only the hood reaches the surface or can be seen without dissection.

The antennæ (Fig. 138, *a*) are located close above the buccal cavity and seem to consist of a basal fleshy segment and two, slightly-elongated pieces side by side at the apex. These are located on a fleshy, partly bifurcated process of the head segment. The small pieces at the tip are not alike in appearance; the one nearer the middle line is abruptly constricted near its middle, beyond which it continues with less than a fourth its diameter at the basal half. The outer one is of nearly equal diameter to the truncate apex.

The integument as a whole is provided with short, flexible, light-colored hairs (Fig. 136, *b*), which are specialized on the pro-legs, on the posterior breathing appendage, and also into the segmental hairs.

The anterior spiracles (Figs. 131, *b*; 132), are borne on a pair of horn-like prominences which are capable of considerable extension but are usually rather closely retracted. The tip is marked by a sub-circular opening guarded by twenty rounded lobes.

The pro-legs, of which there are seven pairs, are simply ventral, knob-like projections of the body surface, over which the ordinary integumental vestiture has become specialized (Fig. 138, *c*). The hairs are larger, heavier, and decidedly curved and retrorse; there are several sizes of these hooks on each pro-leg. They are very efficient organs of locomotion in soft mud or over hard surfaces, and in the present case doubtless enable the larva to migrate to the place of pupation as described below.

The anal opening is located ventrally near the base of the "tail." It is slit-like, and is very peculiar in that it opens among a group of soft, retractile, radiating flabellæ about a dozen in number. These flabellæ may be entirely retracted so as to be invisible, and are at intervals rapidly unfolded presenting a beautifully symmetrical arrangement (Fig. 137). Buckton suggests that they may have a renal function.

The posterior respiratory appendage (Fig. 131, *d*) is a most remarkable and highly specialized organ which enables the larva to feed at various depths beneath the water without coming to the surface for its aerial respiration. The spiracles are situated distally on an elongated tube-like appendage, which is extensile and retractile in a telescopic manner. It is composed of three sections of different caliber and superficial appearance, each double in nature, enclosing two tracheæ, but fused medially to the tip, never forked. These sections are capable of sliding one within the other. The one next the body is the largest, nearly cylindrical, half a millimeter in diameter, transversely wrinkled and bearing numerous, soft, concolorous, blunt hairs, similar to those of the body surface (*the integumental hairs*) but only about half as large (Fig. 134). The middle segment of the posterior appendage is about two-thirds the diameter of the basal one, and is

marked by irregular longitudinal ridges bearing, in longitudinal lines, very short, sharp, recurved hairs, broad at the base (Fig. 135). These alternate on any two adjoining ridges. The terminal segment is smooth, shiny, with its surface transversely ridged in a manner which, under low magnifications, suggests a trachea. When more carefully examined, however, the two trachea which run the full length of the tube are easily seen through the outer walls of this segment (Fig. 133, *a*).

The tube terminates in a rounded, convex tip which seems to be perforated by two small semi-circular slits. It is ornamented with four pairs of tiny, delicate, feather-like appendages which open out radially. (Fig. 133, *c*). These are probably lubricated in some way for they seem to repel the water and are not easily submerged. These feather-like structures may be homologous with the inter-spiracular hairs or spines of the aphidiphagous larvæ.

These larvæ can progress through the water by undulatory constrictions of the body, or creep over submerged or exposed objects by the aid of their pro-legs. (Buckton believed that in *E. tenax* the tail is used by pushing from behind to aid the grub in penetrating into soft mud.)

Numerous larvæ were collected in the evaporating vats at the Columbus sewage disposal plant in September. They were found in large numbers swimming about in the very putrid, watery material, near the surface where a kind of scum had collected. Their food is undoubtedly the various decaying materials brought in with the sewage.

These are very interesting animals to watch under a low power microscope: the peculiar undulatory creeping or swimming movements, the retraction and elongation of the breathing appendage, the occasional unfolding of the flabellæ about the anus, and the peculiar opening out and introverting of the anterior segments, lips, antennæ, mouth-hood, etc., besides the action of the viscera all being clearly visible, and fascinating objects for study.

Pupa.

While the change from larval- to pupal-stage in the aphidiphagous forms is not sharply defined, it is clearer there than in the rat-tailed form as illustrated by *E. æneas*; because in the latter case, the shortening and dorsal inflation are proportionately not so great.

Length 8-10 mm., height 3-4.5 mm., width 3.5-4.5 mm. Shape elongate-ovoid, much like that of the larva but considerably shortened, and somewhat inflated dorsally; so that as seen from the side (Fig. 145) the dorsal line is strongly convex in front and behind, weakly so along the middle. The ventral line is

nearly straight. From its posterior end arises the tail-like respiratory appendage (Fig. 145, *c*) which is usually curved anteriorly above or around the body. It is commonly shortened to a length of 8 to 10 mm. of which the basal segment often forms about two-thirds, the terminal one usually being second in length. The tracheal tubes from these appendages soon become constricted off a short distance within the main body of the puparium and are not functional during most of the pupal stage.

At the approach of pupation there appears under the larval skin, about one segment back of the anterior or larval respiratory cornua, (Fig. 131, *b*; 145, *a*), a pair of rounded darkened areas. These soon become elevated to a length of about 2 mm.; their diameter being about 0.25 mm., rather uniform to near the tip where they round off (Fig. 145, *b*). They are provided on the distal three-fourths or four-fifths of their length with several hundred, short, rounded tubercles (Fig. 147). These tubercles are somewhat collected into groups, and, especially along the anterior-median surface, are absent over a longitudinal stripe. When highly magnified each tubercle is seen to be ornamented on the tip with about 8 or 9 radial elevations, which I take it are the spiracles. (Fig. 148). The elevations as a whole are called the pupal respiratory cornua. Internally to the puparium they continue as large trachea, which attach to the dorsal part of the prothoracic segment of the developing nymph (Fig. 146, *a*). There is thus quite clearly a special provision for pupal respiration.

These might be considered homologous with the prothoracic spiracles of the adult fly; and since they penetrate the puparium about one segment back of the anterior larval respiratory cornua, it might seem improper to consider the larval segment which bears the latter the prothoracic. Nevertheless, it does not seem to me that the point at which these pupal cornua emerge should be considered of much significance. The larval skin at this time is much distorted out of its normal shape by contraction and inflation and it would not seem that segmental homology could longer hold.

The larval respiratory cornua (Fig. 145, *a*) become fixed at a length of about 0.75 mm. their diameter being slightly less than that of the pupal cornua just described. They are recurved slightly to a sharp point. The sub-circular group of rounded lobes at its tip in the larva (Fig. 132), become obscure in this stage. Internally the trachea from these cornua are constricted off and have no connection with the pupa, at least in its more advanced stages.

The buccal cavity, antennæ, etc., are retracted within the puparium a short distance back of the anterior end where the dorsal elevation begins. Internally the œsophageal framework is flattened against the ventral wall of the puparium from which the

pupal body becomes separated. The position of the seven pairs of pro-legs and of the anal opening are shown as scars on the puparium (Fig. 145, *e*, *d*).

The color of the puparium with the pupa enclosed is a very dark brown. When empty and dried it is brittle, and a very pale ashy-brown in color. The larval wrinkling remains visible to a slight extent.

Pupæ of this species were found in abundance at the sewage disposal plant the middle of September. The walls of the vats are of cement and are, much of the time, six or eight feet higher than the level of the water. They are surmounted by an iron railing. In the angles of this railing, or on the sides of the wall, wherever a crevice or angularity presents itself, numbers of puparia were found massed together and considerably overgrown with webs of spiders. During the winter the empty puparia in these locations form excellent nests for the spiders.

Buckton, writing about *E. tenax*, states that the larvæ buried themselves in soft mud, each forming a small dome over itself, and so pupating under a shallow covering of mud. This method of pupation would be a protection against drought. The pupæ taken about the middle of September emerged as adults September 26, so that the duration in this stage was at least ten days to two weeks. During the winter all the puparia that could be found were empty or contained dead nymphs. Does the fly pass the winter in some other stage, or can it be that the puparia left exposed cannot winter and that normally they bury themselves in mud? If the latter is true, other puparia at this place may crawl farther and bury in the soil.

Adult.

Description slightly modified after Williston, Synopsis N. A. Syrph. pp. 161, 162.:

"Male and female: Length 8 to 10.5 mm. Dark metallic green, wholly shining. Thorax sometimes with a bluish reflection. Eyes brownish, spotted with small round dots of darker (Plate IV, Fig. 150). [This character sometimes disappears after death]. The eyes are nearly bare, very slightly pilose near the top. Face and front with grayish pile and pollen, a small spot on the tubercle and the cheeks narrowly shining. Antennæ brown, dorsal part of third joint darker; often the first two joints yellowish; arista bare. Thorax and abdomen with obscure yellowish pile. Dorsum of the thorax in the female with five grayish-white stripes, the middle one slender, linear, the two lateral ones broader (Plate IV, Fig. 150). Scutellum with the same dark metallic green. Tibiæ at the base, sometimes for nearly half their length, light yellow; middle, sometimes all the metatarsi, yellowish; the femora, except the tip, black; distal portion of tibiæ blackish brown. Wings hyaline."

Didea fasciata Macquart, var. **fuscipes** Loew.

(Plate IV, Fig. 17.)

(An addition to the life-history notes on this species published in The OHIO NATURALIST, Vol. XI, No. 7, pp. 337-341, May, 1911).

Egg.

Elongate oval in outline, sub-cylindrical, but flattened ventrally and arched slightly dorsally; broadest about the middle. Length 1.3 to 1.7 mm., diameter 0.4 to 0.6 mm. Color chalk white. The chorion is sculptured in a characteristic manner. The projecting bodies are close together, not highly elevated, each one two to four times as long as broad. There are 55 to 60 of these bodies lengthwise of the egg and 80 to 100 around it at the middle. The egg of *Didea* differs from all the others I have seen in that the projecting bodies are not smooth on the top but each one has a small number (6-10) of more or less angular, irregular-shaped, pit-like depressions hollowed out of it. These are so arranged as to leave between them an elevated part of the body with more or less parallel sides. The whole effect is to give the arm-like network appearance over the main body somewhat like that between these bodies, without the outlines of the bodies being obscured. The arms between these bodies are irregular, slightly branched, for the most part rather short, sometimes long, from 10 to 15 radiating from each body.

Eggs already hatched and larvæ apparently 5 or 6 days old were taken on sycamores at Columbus, September 28, 1911. A number of eggs, not hatched, and nearly full-grown larvæ were taken October 7.

The eggs are scattered singly along the under side of the low, spreading, more or less horizontal branches of the sycamore (*Platanus occidentalis* L.) at a time in autumn when the colonies of aphids (*Longistigma caryæ* Harris) are just being established, or even in anticipation of their arrival. Indeed it seems to me likely that the latter is usually the case. Certainly many eggs can be found in branches where no aphids are yet to be seen. They are laid flat down, glued by the posterior half of the ventral side to the bark, and are of such a size and color as to be readily seen on close examination with the naked eye.

EXPLANATION OF PLATE IV.

Figures 81-89 *Syrphus xanthostoma* Wills.

- Fig. 81. Antero-ventral view of head of larva much enlarged; *a*, sensory papillae; *b*, antenna; *c*, upper jaw; *d*, outer pair of mouth-hooks; *e*, other mouth hooklets; *f*, lower jaw; *g*, anterior spiracles or larval respiratory cornua; *h*, oesophageal framework, within.
- Fig. 82. Lateral view of larva, x 6; *a*, median segmental spines; *b*, posterior respiratory appendage.
- Fig. 83. End view of anterior spiracle, highly magnified.
- Fig. 84. Dorsal view of posterior respiratory organ x 40; *a*, one of the three pairs of slit-like spiracles; *b*, one of the inter-spiracular spurs; *c*, the median dorsal spiracular spur; *d*, the circular plate.

- Fig. 85. End view of posterior respiratory organ, x 50; lettering as in Fig. 84.
 Fig. 86. Dorsal view of puparium x 3; *a*, posterior respiratory appendage.
 Fig. 87. Lateral view of puparium x 3.
 Fig. 88. Scutellum and abdomen of female from above, showing color pattern, x 5.
 Fig. 89. Wing of male, x 7.

Figures 149, 150 *Eristalis aeneas* (Fab.)

- Fig. 149. Wing of male x 7.
 Fig. 150. Dorsal view of head and thorax of female showing characteristic spotting of the eyes, and pollinose thoracic pattern, x 5.
 Fig. 17. *Didea fasciata fuscipes*; characteristic sculpturing on chorion of egg.

EXPLANATION OF PLATE V.

Figures 142-144, inclusive, *Eristalis tenax* (Linne) all the others of *Eristalis aeneas* (Fabricious). See also Figs. 149, 150

- Fig. 131. Dorsal view of mature larva x 9; *a*, antenna; *b*, anterior larval respiratory cornua; *c*, the large tracheal trunks; *d*, the posterior respiratory tube or "rat-tail." To avoid a confusion of detail the vestiture is not represented in this figure.
 Fig. 132. The anterior larval respiratory cornua, much enlarged, dissected out to show the large trachea leading from it.
 Fig. 133. Distal end of respiratory tube highly magnified, showing wrinkling on outside, the two inner tracheae (*a*), the spiracles at the tip (*b*) and the delicate, feather-like appendages (*c*).
 Fig. 134. A small area of the basal segment of the tube much enlarged, showing the character of the vestiture and wrinkling.
 Fig. 135. A small area of the median segment of the tube much enlarged, to show the character of the vestiture and wrinkling.
 Fig. 136. *a*, one of the bifid, segmental hairs of the larva, and *b*, one of the integumental hairs of the body drawn to the same scale as Figs. 134 and 135.
 Fig. 137. The anal opening of the larva (*a*) with the retractile flabellae (*b*), much enlarged.
 Fig. 138. Ventral view of the head of the larva much enlarged; *a*, antenna; *b*, mouth hood; *c*, the first pair of pro-legs.
 Fig. 139. Ventro-lateral view of hood and oesophageal framework dissected out, much enlarged.
 Fig. 140. The chitinized mouth-parts internal to the hood from the side; *a*, hooklets, possibly homologous with those of aphidiphagous larvae; *b*, mandible-like structures; much enlarged.
 Fig. 141. The same as Fig. 140, ventral view.
 Fig. 142. Eggs of *E. tenax*, x 17, showing method of ranking in oviposition.
 Fig. 143. Sculpturing of chorion of egg of *E. tenax*, highly magnified.
 Fig. 144. Larva of *E. tenax* a few hours after hatching; *a*, antenna; *b*, one of the prolegs; *c*, tracheal trunks; *d*, posterior respiratory appendage, x 17.
 Fig. 145. Puparium of *E. aeneas* from the side, x 4; *a*, anterior larval respiratory cornua; *b*, pupal respiratory cornua; *c*, posterior respiratory appendage; *d*, anal flabellae; *e*, pro-legs.
 Fig. 146. Nymph, or developing imago, dissected out of puparium to show connection of tracheae from pupal respiratory cornua to prothorax (*a*); *b*, knee of front leg; *c*, wing-pads; *d*, scutellum; x3.
 Fig. 147. Pupal respiratory cornua very much enlarged showing arrangement of spiracular papillae.
 Fig. 148. Two of the papillae of the pupal respiratory cornua showing radiating structures believed to be the spiracles.



